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Cereal Hays for Ohio

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CONTENTS

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CEREAL HAYS FOR OHIO

L. E. THATCHER

The agricultural statistics for Ohio, published in the report of the Fifteenth Census (1929) of the United States, show that 20,843 acres of small grains were cut for hay in the State in 1929 and yielded 18,949 tons. This acreage was confined largely to the southern third of the State. At the same time, 70,184 acres of oats were cut and fed unthreshed, largely in the southern half of the State. Sheaf oats fed to livestock furnish both grain and roughage—the value of the latter depending upon the stage of maturity when cut. The total acreage represented by the cereal hays and sheaf oats fed was only about 3.5 per cent of the total hay acreage harvested in the State that year.

The common hay crops—clover, timothy, alfalfa, and mixtures—ordinarily supply sufficient hay for the needs of the State. There are seasons, however, when these crops are short and emergency hay crops are greatly needed.

Advantages of cereal crops for hay.—The cereals—oats, wheat, barley, and rye—have several advantages when utilized for hay: Their adaptation to the soil and climate is known; the regular rotation need not be disturbed; they are available for feeding early in the season; and they may be adapted to almost any class of livestock by harvesting at the proper stage of development. Cereals that were sown for grain crops may be diverted to this use. The stands of clover and grass seedings made in the cereals are likely to be better if the latter are harvested for hay rather than for grain. If special seedings of the cereals are made for hay and the rate of seeding increased over that used for grain production, the hay will be fine stemmed, soft, and of good palatability. However, the yield per acre will not likely be any greater and may be slightly less than if sown at the optimum rate for grain production; also, clover and grass seedings will not catch as well in the thickly sown crops.

Cereal crops that have lodged badly may be harvested for hay and may be worth more as such than the poor quality grain obtained from the lodged crop. Cereals that are badly rusted or otherwise damaged for grain production may sometimes be harvested advantageously for hay.

Cereals cut for hay dry more slowly than the common hay crops, and, hence, care should be taken to have them well cured before putting into the mow or stack. Since early-harvested cereals are rich in sugars, they are susceptible to the growth of molds if stored with too high a moisture content. The ease of curing is increased as the plants approach maturity.

Estimating the yield of cereal hay.—The yield of cereal hay harvested in the milk to soft-dough stage can be estimated fairly accurately by taking the expected weight of grain and straw when harvested for grain. Oats hay, oats grain, barley hay, and barley grain were grown in adjacent plots for 6 years at Wooster. The oats hay weighed 7 per cent more than the total weight of oats grain and straw; the barley hay, 1 per cent more than the barley grain and straw. Wheat hay, one year only, weighed 6 per cent less than the total grain and straw weight. The yield of rye hay harvested at the full-bloom stage will be less than the total yield of grain and straw.

Nutritive value.—The cereal hays differ among themselves (on the average) in their content of feed nutrients. Individual samples of the same kind of cereal hay will also differ in composition as a result of variation in the stage of maturity when harvested, the fertility of the soil growing the crops, the amount of rainfall, the temperature, etc. Indeed, this variation between different samples of one cereal hay may be greater than the average difference between different kinds of cereal hays.

TABLE 1.—Average Percentage Composition of Hays and Roughages

	Crude protein	N-free extract	Fat	Crude fiber
	Pct.	*Pct.*	*Pct.*	*Pct.*
Barley hay	7.0	47.3	2.2	29.7
Oats hay	8.4	41.7	2.8	28.3
Rye hay—heading out to in bloom	9.8	39.7	2.6	33.9
Rye hay—all analyses	6.7	40.5	2.1	37.5
Wheat hay	6.2	52.6	2.0	24.7
Pea and oats hay	11.4	36.5	2.6	25.6
Wheat and vetch hay	14.5	34.4	2.1	27.2
Red clover hay	12.8	38.7	3.1	25.5
Clover and timothy mixed hay	8.6	40.8	2.4	29.9
Soybean hay	16.0	39.1	2.8	24.9
Alfalfa hay	14.9	37.3	2.3	28.3
Sudan grass hay	8.2	44.7	1.6	26.9
Millet, German, hay	8.0	46.5	2.6	27.3
Timothy hay	6.2	45.0	2.5	29.8
Sorghum fodder	7.4	45.9	3.1	26.1
Corn stover	5.9	46.6	1.6	30.7
Oats straw	3.6	40.8	2.4	36.3
Wheat straw	3.1	44.4	1.5	37.4
Barley straw	3.5	39.1	1.5	36.0
Rye straw	3.0	46.6	1.2	38.9

Table 1 showing the analyses of several roughages is taken from Henry and Morrison, *Feeds and Feeding*, 18th edition (4)[1]. The composition reported is the average of several analyses, as indicated in the table. This serves to point out the relative average nutritive value of the cereal hays compared with other hays and roughages referred to in this publication and some others in common usage in Ohio.

In general, the cereal hays compare favorably with mixed clover and timothy hay in average composition.

The nutritive value at various stages of maturity.—Cereal plants during their early vegetative period (when they consist largely of leaves and before the shoots or culms begin to lengthen) contain a high percentage of water, about 75 per cent, and 4 to 6 per cent of crude protein; this compares favorably with green clover and green alfalfa. The difficulty of curing the succulent growth, together with the relatively small yield, makes it impractical to harvest for hay at that time. If artificial methods of drying are perfected, high-protein hay can be made from many immature crops and rotations can be arranged whereby two or more such crops can be harvested from the land each season.

The nutritive value and palatability of forages in general are influenced by the stage of maturity when harvested. The composition of the wheat plant at various stages has been reported by Trowbridge, Haigh, and Moulton (2), Knowles and Watkin (7, 8), Kedzie (5), Malhorta (9), Snyder (11), Olson (10),

[1]Reference by number is to "Literature Cited", page 13.

and others. Keith and Tarbox (6) studied the oats plant, and Hendry (3) has reported the effect of cutting wheat, barley, oats, and rye for hay at four stages of maturity. Woll (13) carried on feeding trials with wheat, oats, barley, and rye cereal hays in California and says that the immature cereal hays are richer in protein and contain less fibre than mature cereal hays. These investigations show that the cereals have taken up practically all of their nitrogen and their mineral matter and have reached their maximum dry matter content by the time the plants are in the milk to the soft-dough stage. The nitrogen in the plants moves toward the kernels as maturity approaches, and the dry matter in the plants decreases in percentage of nitrogen and increases in crude fibre content. Table 2 gives the crude protein content of some cereal hays harvested at four stages of maturity.

TABLE 2.—Percentage of Crude Protein in Hays, Summary

	Bloom	Milk	Dough	Ripe	Source of data
Wheat (Water-free)	8.27	6.25	6.67	6.57	Missouri (12)
(Air-dry)	9.37	8.17	6.88	7.93	Wooster 1933
(Air-dry)	8.20	6.30	.....	5.80	Wooster 1922
Oats (Air-dry)	10.99	10.85	9.91	10.81	S. Carolina (6)
(Air-dry)	8.40	6.60	6.10	5.70	California (3)
(Air-dry)	.....	7.00	6.40	4.10	Columbus 1929
Barley (Air-dry)	8.00	9.10	8.60	7.40	California (3)
Rye (Air-dry)	9.80	7.30	8.40	4.70	California (3)

Seasonal changes in wheat plants at Wooster, 1933.—In 1933 the author collected wheat plants on six dates at approximately weekly intervals from May 23 to June 28. The plants were cut into three to four sections and the dry weight and crude protein determined on the air-dry samples (Table 3). The first section was taken from the base of the plant and the second, third, and fourth sections successively above the first.

In general, the percentage of crude protein for the total plant decreased with the approach of maturity; the tops, or actively growing parts of the plant, were richer in protein than the older parts; and the relative dry weight of the plant increased in the tops as the plant matured.

Additional data on the composition of rye and wheat hay obtained by C. J. Willard from plots on the Ohio State University farm at Columbus are shown in Table 4. Wheat had a higher crude protein content than rye at equivalent stages of maturity.

NUTRITIVE VALUE INFLUENCED BY SOIL FERTILITY

Top-dressing with nitrogen.—The yield and protein content of wheat or rye hay may be increased under certain circumstances by top-dressing the stand in the spring with readily available nitrogen fertilizer. The effect is most pronounced on soils that are deficient in available nitrogen and during seasons when low temperatures and excessive soil moisture retard nitrification in the soil. Davidson and LeClerc (2) applied nitrate of soda at the rate of 320 pounds per acre to wheat early in the spring when the plants were 2 inches tall, at heading time, and at the milk stage of the kernel; it was also applied as split applications between two or three of these stages. The plants that received the application of nitrate of soda at the second or heading stage

TABLE 3.—Wheat Plants Harvested at Several Stages of Maturity

Ohio Agricultural Experiment Station, Wooster, Ohio

Date harvested, 1933	Plant section	Length	Per cent of plant weight	Per cent crude protein*
		In.		
May 23—boot stage	1st	8	38.95	6.50
	2nd	10	36.05	13.63
	Tops	15–18	25.00	19.50
Total plant			100.00	12.31
May 31—heading	1st	8	30.30	3.00
	2nd	8	26.84	5.88
	Tops	16–20	42.86	11.75†
Total plant			100.00	7.52
June 7—kernels one-half formed	1st	8	28.84	3.50
	2nd	8	20.20	6.06
	3rd	8	18.75	10.00
	Tops	10–22	32.21	12.63
Total plant			100.00	8.17
June 12—soft-dough stage	1st	8	21.94	5.63‡
	2nd	8	17.72	6.56
	3rd	8	16.46	7.88
	Tops	18–28	43.88	12.25
Total plant			100.00	9.07
June 19—dough stage	1st	8	19.91	3.69
	2nd	8	14.92	3.00
	3rd	8	15.92	5.44
	Tops	18–26	49.25	9.81
Total plant			100.00	6.88
June 28—ripe	1st	8	19.38	3.13
	2nd	8	14.98	3.75
	3rd	Sec. to base of heads	22.02	5.44
	Heads	.....	43.62	12.75
Total plant			100.00	7.93

*Moisture 9 per cent. †Probably too low. ‡Probably too high.

TABLE 4.—Composition of Rye and Wheat Hay at Columbus

Approximate dates of cutting	Stage of growth	Average crude protein in hay Per cent
Rye		
May 17	In head	8.6[3]
May 24	In bloom	6.3[3]
May 31	Past bloom	6.3[4]
June 7	.....	5.6[4]
June 14	.....	5.0[2]
Wheat		
May 24	.....	10.2[2]
May 31	Headed	8.8[3]
June 7	.....	8.5[3]
June 14	.....	7.0[2]
June 21	.....	7.4[1]

Superscript figures=number of years averaged.

showed an increase in protein content proportional to the amount applied. When the fertilizer was applied early in the spring, the main effect was to increase the yield of straw rather than protein content.

The effect of top-dressing rye in April with sulfate of ammonia is shown by some data supplied to the author through the courtesy of John Bushnell, Associate in Horticulture at this Station. These data were obtained in the course of some investigations of green manure crops for potatoes (Table 5).

TABLE 5.—Rye Top-dressed With Sulfate of Ammonia at Wooster in April 1932

Amount of sulfate of ammonia per acre	Date of sampling and per cent of crude protein*	
	May 22	June 8
Lb.	*Pct.*	*Pct.*
None	10.57	5.50
100	11.56	5.64
200	12.17	6.51
400	13.52	7.72

*Sample air-dry.

Only two sampling dates are given: May 22, at which time the rye was about 30 inches tall and in the boot stage, and June 8, when it was about 60 inches tall and blooming. The crude protein content of the plant (air-dry) was increased by the top-dressing as shown by the analyses on both dates. A marked increase in dry weight of plant took place in the 18-day period, accompanied by a decrease in the percentage of protein.

The effect on the protein content of the wheat plant is shown by an experiment conducted by the author in which 400 pounds per acre of nitrate of soda were applied to wheat on three dates, March 15, April 15, and May 15, 1922. The effect of the early application was to increase yield more than protein content. The inconvenience of top-dressing wheat after it begins to shoot will confine the farm practice to the period from early March to about the first of May.

TABLE 6.—Crude Protein in the Wheat Plant as Influenced by Top-dressing With 400 Pounds of Nitrate of Soda, Wooster

Top-dressed	Crude protein content at	
	Full bloom	Milk stage
None	7.28	5.83
March 15	7.91	6.29
April 15	8.56	6.17
May 15	10.57	6.81

Whether or not top-dressing with nitrogen fertilizers is advisable will depend upon the vigor of growth of the crop, the need for increased yield and quality of crop, and the cost of the treatment. In general, 15 to 30 pounds per acre of available nitrogen, equivalent to 75 to 150 pounds of sulfate of ammonia, constitute a reasonable application.

Oats or barley intended for hay need not be top-dressed; it is better to apply the fertilizer at seeding time. The standard fertilizer recommendations for the soil and crop should be followed. (These may be obtained from the Department of Agronomy, the Ohio Agricultural Experiment Station, Wooster, Ohio, or from the Department of Agronomy, College of Agriculture, the Ohio State University, Columbus, Ohio.) If additional nitrogen is needed to increase the yield and quality of the hay, it may be added to the regular fertilizer application, or a ready-mixed fertilizer may be used which contains a higher percentage of nitrogen.

OATS HAY

Oats are the best of the cereal crops for hay. Oats hay contains more protein than the other cereal hays and is ready for harvest later in the season when favorable curing weather obtains. If cut in the milk stage, it will contain more protein than if cut later; and, if well cured, it will be more palatable. Feeding trials at the North Carolina Agricultural Experiment Station show that good oats hay is about equal to mixed clover and timothy in feeding value (1). Late and medium maturing varieties of oats will yield more hay per acre than the early ones. Assuming that the yields of hay are comparable to the total yield of grain and straw, some Wooster data show that the early sorts should yield about 90 per cent as much hay as the later ones. Early seeding is not as necessary for oats hay as it is for oats grain production, since the filling of the kernels is not important for hay. However, the yield from late seeding usually will be somewhat less.

Yield.—Since no rate-of-seeding test has been conducted at the Station in which oats were cut for hay, our only source of information regarding probable yields is that derived from the grain test. Table 7 gives the total weight of grain and straw at several rates of seeding. In a 6-year period including 12 separate tests, the rate of seeding was carried up to 16 pecks per acre. The total yield was as follows: 8 pecks, 4562 pounds; 12 pecks, 4426 pounds; and 16 pecks, 4305 pounds. Apparently, a range of 6 to 12 pecks of seed per acre will produce a full crop of hay. The hay becomes finer stemmed as the rate of seeding increases but there is danger of the crop lodging at the higher rates of seeding.

TABLE 7.—Rate of Seeding Oats

18 years and 35 separate tests, Wooster

	Pecks per acre									
	4	5	6	7	8	9	10	11	12	14
Total yield per acre, in pounds.....	4430	4435	4617	4631	4572	4660	4540	4644	4546	4407

Feed nutrients in oats hay versus oats grain and straw.—An acre of oats will furnish about the same quantity of feed nutrients either as hay or as grain.

Miami oats have averaged 67.5 bushels of grain and 2682 pounds of straw per acre at Wooster for a 20-year period. The assumed yield if harvested for hay would have been 4842 pounds per acre. The digestible feed nutrients, calculated from Henry and Morrison (4), are estimated in Table 8.

Since oats straw is used principally for bedding and is seldom fed because of its low nutritive value, oats grain may be compared with oats hay. The latter would furnish slightly more digestible protein and total nutrients per acre than the grain. It must be borne in mind, however, that the grain is about double the concentration of the hay and that oats hay is not a substitute for grain in the ration.

TABLE 8.—Estimated Digestible Nutrients per Acre

Miami oats—20-year average

	Crude protein	Carbohydrates	Fat	Total
	Lb.	*Lb.*	*Lb.*	*Lb.*
Oats grain	209	1125	82	1521
Oats straw	27	1142	24	1223
Total	236	2267	106	2744
Oats hay	218	1845	82	2247

Oats should be cut for hay when the kernels are in the milk to the soft-dough stage if the hay is to be fed to cattle or sheep, since a high percentage of digestible protein and good palatability are required by these animals. Horses will make good use of oats cut when a little more mature. In fact, oats cut a few days before the normal harvesting stage for grain are frequently fed as sheaf oats to horses.

WHEAT HAY

Wheat hay is somewhat inferior to oats hay cut at equal stages of maturity, since it will contain less protein. Cut in the early milk stage, however, and well cured, it is palatable and will equal oats cut in the soft-dough stage in protein content. At the Missouri Station (12) it had a little higher protein content than did timothy at comparable stages of harvest. Beardless varieties of wheat are preferred to the bearded sorts for hay.

It is not likely that wheat will be sown purposely for hay; if used at all, it will be some that was intended for grain. No changes in rate of seeding need be considered. It so happens that the rates ordinarily used for grain production in the Wooster tests have given the maximum tonnage of grain and straw.

If wheat grain is low in price and hay scarce and high priced, harvesting wheat for hay may be justified. Wheat badly mixed with rye usually has a low market value as grain and may be worth more as hay. Wheatfields badly contaminated with cheat might be cut for hay; if cut in the milk stage of the wheat kernel, very few cheat seeds will have ripened.

In the spring of 1933, a small field of wheat on the Ohio Agricultural Experiment Station farm was pastured with dairy cows from April 24 to May 8 and was eaten close to the ground[2]. A sample of the wheat was taken at the beginning of the pasture period. It was 12 to 14 inches tall and contained 4 per cent of crude protein on the green basis or 20 per cent on the moisture-free basis. After the cows were removed, the wheat recovered and was cut for hay June 20, yielding at the rate of 4600 pounds per acre and containing 25 per

[2]In cooperation with C. C. Hayden, C. F. Monroe, and C. E. Knoop of the Department of Dairy Industry.

cent moisture and 7.2 per cent crude protein. The season was very favorable for renewed growth after early pasture. The hay was cured without rain and was fed in a palatability test to dairy cows by C. E. Knoop, Assistant in Dairy Industry. Four Jersey and two Holstein cows, on good blue-grass pasture, except at milking time, were fed all the wheat hay they would consume at milking time for a 9-day period. The average daily consumption of wheat hay was 3.9 pounds, ranging from 5 pounds daily for each of the Holsteins to 2.2 pounds for one Jersey cow. Its palatability was good since these amounts compared favorably with those of soybean hay consumed just previous to feeding the wheat hay.

BARLEY HAY

One serious fault of barley hay is that the beards may cause sore mouths in livestock. If cut in the milk stage of the kernel when the feeding value is high, the beards are tough and cause more trouble than if the crop is cut more mature, at which time the beards are brittle. A large acreage of barley is cut for hay in California where the best barley hay has a bright golden color, much shriveled grain, and brittle beards. In California (3) the recommendation is to cut just as soon as the stalk and head begin to turn yellow but while the leaves are still green. The use of the new smooth-awned varieties of barley, such as Velvet, Glabron, and Wisconsin No. 38, might eliminate some of the objection to the old-fashioned, rough-awned sorts. Hooded barley (sometimes improperly referred to as beardless barley) makes inferior hay, low in palatability and nutritive value.

Barley intended for a grain crop may be cut for hay in an emergency but should seldom be sown purposely for hay since oats are much better.

RYE HAY

Rye is the least desirable of the cereal crops for hay because of low palatability and high fibre content. It is fairly usable if cut when well headed out but not later than the full-bloom stage. It is ready to cut earlier in the season than the other cereals, but the weather is likely to be less favorable to curing.

LEGUME AND CEREAL MIXTURES

The feeding value and occasionally the yield of cereal hays can be improved by growing them in combination with legumes. Practical mixtures are rye and hairy vetch, wheat and hairy vetch, oats and field peas, wheat and sweet clover, oats and sweet clover, and oats, field peas, and sweet clover.

Mixtures of rye or wheat with hairy vetch should be sown about the time wheat sowing is at its height or a little before. If sown too early or too late, much winterkilling is likely to occur. At Wooster, good stands have been obtained from late August and early September seedings, and, at Columbus, mid-September to October first seedings have been satisfactory. Rye is preferable to wheat for sowing early in the fall before the Hessian fly-free date, because it is not so subject to Hessian fly injury.

Wheat and vetch are more desirable than rye and vetch for hay because wheat and vetch mature together. Rye has passed the bloom stage and become almost inedible before vetch has reached its maximum growth, as shown by tests at Columbus.

On thin, drouthy soils, rye and vetch may be expected to yield somewhat higher than wheat and vetch.

Four to 6 pecks of rye or 6 to 8 pecks of wheat and 20 to 30 pounds of hairy vetch seed will sow an acre. The cereal grain and hairy vetch seed should be kept thoroughly mixed in the grain box of the drill to insure even seeding. The hairy vetch seed should be inoculated unless a crop of inoculated vetch or field peas has been grown on the land within recent years.

Wheat or rye and hairy vetch should be harvested for hay when the cereal crop is ready, as suggested for wheat hay or rye hay.

The feeding value of the mixture will be increased as the percentage of vetch increases in the hay.

The crude protein of hairy vetch hay is high, as shown by 18 analyses of samples, harvested at Columbus by C. J. Willard, representing several seasons and stages of maturity. No sample ran below 20 per cent crude protein, several ran 23 per cent, and one harvested on May 16 ran over 26 per cent.

A word of caution to wheat farmers should be inserted here. Hairy vetch is likely to become a weed pest in wheat or rye fields, because some hard vetch seeds may lie in the soil for a year or more without sprouting and finally come up as a volunteer crop in the grain field. It ripens with the grain and the seeds are as difficult to remove from the threshed grain as is cockle and are as objectionable to the millers. Once established on a farm, it is hard to eradicate. It is not objectionable except as noted.

Sweet clover with wheat, oats, or barley.—Sweet clover may grow almost as tall as the grain crop with which it is seeded on good soil and with favorable moisture and temperature in the spring. This is objectionable if the crop is harvested for grain, as many farmers have learned by experience, because of the difficulty of drying out the sheaves containing the green sweet clover. The mixture makes good hay, however, because the sweet clover adds to its feeding value. Good drying weather is needed to cure the mixture thoroughly before putting it into the mow.

OATS AND FIELD PEAS

This combination will produce hay of higher feeding value than oats alone but the yield may be less. Table 9 gives the 7-year average yield and the 3-year average crude protein content for three rates of seeding at Wooster.

TABLE 9.—Oats and Field Pea Hay, Wooster

Mixture of seed	Yield, 7-year average	Crude protein, 3-year average
Bu. per acre	*Tons*	*Per cent*
Peas 2, oats 1	2.66	10.1
Peas 1.5, oats 1.5	2.64	9.5
Peas 1, oats 2	2.78	9.0

The combination is limited approximately to the northern third of the State or to that section where medium to late varieties of oats are well adapted. Field peas require a long, cool growing season in the spring and early summer and soils with a high water-holding capacity. Light sandy or gravelly soils are unsuited to the crop. Since field peas are more sensitive to soil acidity than are oats, the soil should be at least sweet enough to grow red clover successfully and will do better at higher reactions, or from pH 6.5 to 7.

One handicap to the mixture has been the high cost of field pea seed. No less than one bushel of peas per acre should be sown in the mixture and one and one-half bushels are better. Three bushels of the mixture will seed an acre.

Early seeding is essential and on most soils the peas should be planted first and deeper than the oats, or at 3 to 4 inches. This double drilling increases the labor but may mean the difference between a good and poor crop of peas. The pea seed should be properly inoculated and the fertilizer, if any, put on with the oats. The mixture may be sown at one operation on highly organic soils or others that permit deep planting of oats.

Medium to late varieties of oats are better than early oats for growing with field peas because they reach the best stage of maturity for hay at about the same time that the peas do. Field peas, such as are sold generally by seedsmen, will be fairly satisfactory, providing the seed is free from wilt disease. The purchase of inspected, northern-grown seed will overcome that danger.

The mixture may be harvested from the time the oats are in the milk to the dough stage. The later date may be preferable from the yield standpoint if the peas are growing well. If the pea vines show signs of drying up, harvesting should not be delayed, provided the oats have reached the milk stage.

If the peas are filling well and prospects are good for a seed crop, part of the crop may be allowed to ripen and threshed for grain (thus providing seed for the following year) or it may be ground for feed.

Clovers and grass seed mixtures may be sown with peas and oats with generally satisfactory results.

CEREAL MIXTURES FOR HAY

Nothing is to be gained by sowing mixtures of wheat and rye or oats and barley to be cut for hay. Occasionally, wheat fields that have suffered severe reduction in stand because of winter injury are reseeded to oats on many farms. This mixture of wheat and oats may be worth more for feed as hay than as matured mixed grain. Wheat badly contaminated with rye has a low market value. Here too, harvesting the mixture for hay may well be considered.

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